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DIPHTHERIA

ITS PREVENTION AND CONTROL

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DIPHTHERIA.

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Diphtheria is justly regarded as one of the most dreaded of the diseases of childhood. It has come down to us from antiquity under such names as "Egyptian sore throat," "Syrian ulcer," "malignant" or "putrid sore throat," "gangrenous ulcer," and the like, until its present name was given the disease by the great French physician, Trousseau, in the first part of the nineteenth century.

Until the fruitful discoveries of Klebs, Loeffler, Behring, and others gave us the cause and methods for the cure and control of diphtheria, few diseases had presented such high mortality, and there had been few before the march of which we were apparently so helpless. An outbreak of diphtheria in a community caused a shudder of horror, for the old records are full of instances where all the children of a family were swept away, in spite of all that the medical knowledge of that time could do.

Thanks, however, to our modern discoveries, there are few diseases about which we know so much as diphtheria. Its prevention and control are feasible provided we have the intelligent cooperation of the sanitary authorities, the medical profession, and last but not least, the general public. It is to the latter that this little brochure is addressed.

Before proceeding to discuss the cause, symptoms, control, and prevention of diphtheria, we ought to refer briefly to the "habits" of the disease, namely, its seasonal prevalence, where it is found, the ages at which it is most prevalent, and similar facts in relation to its spread.

Climate and season.—Diphtheria is a disease of temperate climates. It seems to be comparatively rare in the Tropics. So far as seasonal prevalence is concerned, while present the whole year round, it is decidedly more common in the colder months, June, July, and August showing the least number of cases.

Geographical distribution.—Formerly diphtheria seems to have been confined to more or less restricted regions. Its spread over the whole civilized world, however, has gone hand in hand with the development of modern transportation facilities. In cities in the Temperate Zone the disease is always more or less prevalent. In rural communities it is more apt to occur in epidemics.

Age and diphtheria.—The victims of diphtheria are found chiefly among children less than 5 years of age. Figures published by the New York City department of health show that 81 per cent of the total deaths from diphtheria in that city were in children under 5 years of age, while the mortality statistics of the Federal Census Bureau tell us that in 1909 about 65 per cent of all the deaths from diphtheria and croup in the registration area for deaths (including about 60 per cent of the total population) occurred in children under 5 years old.

The cause of diphtheria.—Diphtheria is caused by the growth, usually in the throat, nose, or windpipe, of a germ known as the Klebs-Loeffler bacillus, discovered by Klebs and first studied by Loeffler. The appearance of this germ under the microscope is shown in the accompanying cut.

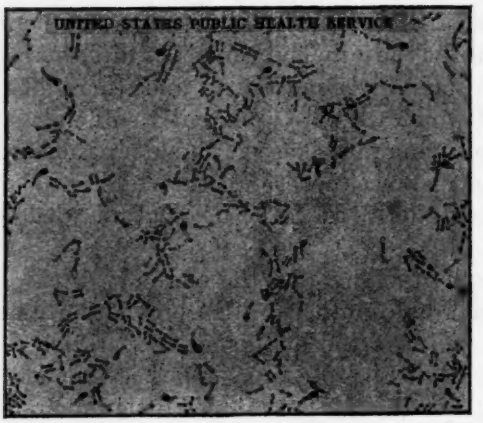


FIG. 1.—Diphtheria germs stained and highly magnified.

The form of this germ is quite distinctive, so that trained observers have little difficulty in distinguishing diphtheria germs from the ordinary germs found in the throat.

The diphtheria germ is constantly found in all persons suffering from diphtheria at the spot where the disease process is going on, and also, occasionally, in the throats of healthy persons, to whom, apparently, it may do no damage, but who, nevertheless, are capable of giving the disease to others. These are the so-called "diphtheria bacillus carriers," of whom we shall speak more fully later.

The presence of the diphtheria germ in the affected parts causes the formation of a peculiar grayish membrane. The germ multiplies in this membrane and at the same time throws off a powerful poison or "toxin," which can cause death when absorbed by the body in sufficient quantities.

Vitality of the diphtheria germ.—Fortunately for us the diphtheria germ is rather frail. It is easily killed by ordinary disinfectant solutions, such as a 1:1000 solution of bichloride of mercury (two 7½-grain tablets to the quart of water) or a 2 per cent solution (5 teaspoonfuls to the quart of water) of phenol (carbolic acid). Under ordinary circumstances the germ is rather easily killed by drying, but when it is contained in pieces of membrane, such as are frequently coughed up in the course of diphtheria, it may live for some time. Instances

are on record of the germs preserving their vitality for months when such pieces remained in damp and dark basements or cellars. It has also been found that diphtheria germs, dried on such objects as a child's building blocks, may remain alive for several months. Heat quickly destroys diphtheria germs.

How the presence of the diphtheria germ is detected in cases of diphtheria.—Most of our knowledge of the form and properties of the various germs of communicable diseases arises from the fact that, aside from finding them in the bodies of the sick, they may be grown artificially, in the laboratory, on various substances given the general name of "culture media." These media are broths and jellies of various compositions often specially adapted to the needs of the germ it is desired to grow. As a result of a great deal of experimenting a culture medium has been found upon which the diphtheria germ outgrows the other ordinary germs which are always present in the throat, mouth, and nose. If, then, we suspect that a person is suffering from diphtheria, a sterilized cotton swab is taken, rubbed over whatever spot seems to be affected, and then passed gently over the surface of the proper culture medium for diphtheria bacilli, contained in a test tube. If the diphtheria germs are present some will cling to the swab and subsequently rub off onto the surface of the culture medium.

The tube is then kept in a warm spot for 8 to 12 hours, at the end of which time colonies of the diphtheria germs, looking like minute drops, will appear on the surface of the culture medium. A particle of the growth is taken, rubbed up with a little water on a glass slide, dried, stained with an aniline color, and examined under a microscope. The expert can often, however, make a diagnosis by examining microscopically some of the material rubbed directly from the swab onto a glass slide. Most cities maintain laboratories where physicians can have the cultures examined which are taken from those suspected of having diphtheria, and many State boards of health maintain similar laboratories where cultures may be sent from rural communities.

The symptoms of diphtheria.—While diphtheria may affect other regions of the body, the usual sites of the disease are the tonsils and the throat. Under these circumstances the most characteristic symptoms are sore throat; the formation, usually on the tonsils and neighboring parts, of a grayish membrane which has a tendency to spread; pallor; headache; rapid pulse; and fever.

Types of diphtheria infection.—We may divide infection with the diphtheria germ into three general types:

1. A simple local infection with membrane formation, but without other symptoms.

2. A local diphtheritic process with general illness following the absorption by the system of the diphtheria poison.

3. The septic form of diphtheria, so called because besides the diphtheria germs the body is infected with other accompanying germs. These three types merge into each other so that we can not always separate them strictly. They are useful, however, as a basis for classification.

Simple local diphtheria.—In simple local diphtheria the symptoms are trifling. There is slight fever, rise in the pulse rate, loss of appetite, and headache. The patient complains chiefly of sore throat, especially on swallowing. This is caused by the swelling of the tonsils and neighboring parts. On looking into the throat we see that a grayish membrane is forming, usually upon the tonsils with extensions upon the soft palate and vicinity. As soon as the membrane disappears the patient's fever drops. In some cases the infection is so mild that the membrane is scarcely visible. The light nature of the symptoms may be ascribed either to considerable natural resistance to the disease or to the fact that but little of the diphtheria poison has been absorbed.

Diphtheria with general illness.—In the second type of diphtheria infection, in which absorption of the poison takes place, the fever is high from the beginning. The patient is usually restless, delirious, with rapid pulse. All the throat symptoms are very much more pronounced. There is a tendency for the membrane to spread up into the interior of the nose and down into the windpipe. The extension of the membrane to the windpipe is apt to cause difficulty in breathing to set in. The pulse is then small and irregular; there is air hunger; the surface of the body becomes cool and clammy; the lips and face are livid. Death may follow from actual suffocation or by heart failure through the action of the diphtheria poison.

Septic form of diphtheria.—In the septic form of diphtheria we have the symptoms of a very severe illness from the outset. The membrane not only tends to spread rapidly, but to cause the death of the underlying tissues. Large sloughs form, which, when they come away, leave deep ulcers behind. The odor of the breath becomes almost intolerable. In this form of the disease, infection by the diphtheria germ is accompanied by simultaneous infection with pus germs which invade the tissues. The near-by lymphatic glands of the neck are infected. As the natural resistance of the body has been sapped by the action of the diphtheria poison, the accompanying germs may penetrate to all the organs of the body.

Other sites of diphtheria infection.—While the usual seat of the diphtheritic process is the mucous membrane of the throat, such is not always the case. The infection may have its starting point in other places as, for instance, the nose, within which a thick diphtheritic membrane may be developed. Nasal diphtheria is justly dreaded, not only because of the fatality in acute cases, but because

the disease in this situation tends to become chronic. As the symptoms of nasal diphtheria may, at first, be only those of an ordinary "cold" in the nose, and because it is much more difficult to see into the nose than into the throat, the disease, under such circumstances, may readily escape detection. Starting points for epidemics may be furnished thereby.

Diphtheria may also begin in the larynx and windpipe, instead of the throat, thus giving rise to membranous croup or laryngeal diphtheria, the most serious of all forms of the disease. The extension of the membrane from the throat into the windpipe during the course of the disease is also an extremely frequent and dangerous complication of throat diphtheria. Under these conditions we not only have an extensive poison-producing surface, but symptoms of suffocation are caused by the swelling of the parts. The membrane may even extend down into the lungs and cause pneumonia.

Besides the nose, throat, and windpipe, diphtheria infection can spread from the throat to the mouth, so that even the lips become involved, or the ear may become infected through the canal (the Eustachian tube) by which it opens into the throat. The delicate lining membrane of the eyelid or conjunctiva may become affected, causing diphtheritic conjunctivitis. Instances have been observed of the growth of the membrane in the intestines. Wounded surfaces, too, may become involved, giving rise to wound diphtheria.

Diphtheritic paralysis.—A common complication of diphtheria is the paralysis of one or more groups of muscles which takes place either in the course of the disease or during convalescence, even from mild attacks. The muscles chiefly affected are those of the palate, the throat, and the eye. Other muscles, however, may also suffer. These paralyses are produced by the action of the diphtheritic poison upon the nerves.

Paralysis of the nerves of the heart may take place, causing sudden death even a considerable time after the local symptoms have vanished and the patient was thought to be out of danger.

The poison or "toxin" of diphtheria.—A few words as to the poison generated by the diphtheria germ may be of interest. The germs themselves multiply chiefly at the site of membrane formation which, as a rule, is in the throat, nose, windpipe, or all three in extensive diphtheritic infections. The poison they produce, however, is readily taken up by the body and penetrates the system. The poison seems to be especially injurious to the heart, blood vessels, nerves, and kidneys. It is due to the action of the poison that we get the somnolence, listlessness, small and rapid pulse, the ashy color of the face, the restlessness, the inflammation of the kidneys, the paralyses, and the ominous symptoms of bleeding from the nose or from the

diphtheritic membrane, and discolorations of the skin in the course of diphtheria.

The poison of diphtheria is no imaginary product invented to account for the symptoms caused by the disease. It can be readily manufactured, in the laboratory, from diphtheria germs. Extremely small amounts of the poison injected under the skin will produce death in animals.

Period of incubation and duration of diphtheria.—The period of incubation of diphtheria, i. e., the time which elapses between receiving the infection and the first symptoms of the disease, is short, from two to five days in cases in which this has been traced. The duration of the disease is very variable; from a few days to weeks or even months, especially in cases of nasal diphtheria. On the other hand the disease may be so severe at the outset that death takes place within 24 hours.

How diphtheria is "caught."—Each new case of diphtheria is derived from a previous case or from a "diphtheria bacillus carrier" (i. e., an apparently well person who harbors the diphtheria germ in his nose, mouth, or throat). The disease is spread from the infected to relatives, friends, schoolmates, attendants, or even to strangers in crowds and street cars because the germ of diphtheria lodges on the hands or the mucous membranes of such persons. The infection is caused either by direct contact, as by kissing or by being sprayed with the germ-laden droplets of moisture thrown out in the act of coughing or sneezing, or indirectly through the agency of various objects such as pencils, apples, candy, eating utensils, drinking cups, and the like, which have been placed in the mouth or sprayed with the nose, mouth, or throat discharges of persons infected with the diphtheria germ.

The underlying principle which governs the transmission of the disease is the freedom with which exchanges of the mouth and throat fluids take place in human beings. A very little watching is enough to convince us of the many times during the day that the hands are carried to the mouth and then handle objects in common use. The greater tendency in children to place objects in the mouth and their closer contact with each other and with adults is perhaps one reason why children take diphtheria more frequently.

With the exception of the part played by milk in the spread of the disease, to which reference is made later, other modes of infection are unimportant. The old belief that diphtheria can be spread through sewer gas, polluted soil, rotting refuse, or through the air is unsupported by reliable evidence.

Diphtheria "bacillus carriers."—By the term "bacillus carrier" we mean a seemingly well person who harbors in his body and may infect others with the germ of some communicable disease, such as

diphtheria, typhoid fever, cholera, cerebrospinal meningitis, and the like. The part played by "carriers" in the spread of disease was first brought out in the study of diphtheria.

It was early noticed that the germ of diphtheria might be found in the nose, mouth, or throats of apparently healthy persons and, furthermore, that such germs might be virulent, i. e., capable of giving the disease to others. Persons who have been in contact with those suffering from diphtheria are, of course, specially apt to be "carriers," yet a certain percentage of the population of any community will be found harboring the diphtheria germ even when they have had no known connection with any case of diphtheria. This percentage of the population probably varies, being greater when there is much diphtheria in the community.

There seems to be a relation between the frequency with which the diphtheria germ is found in the throats of persons in whose house there is a case of diphtheria and the care taken in isolating the sick. When this has been thoroughly done, about 10 per cent of the other members of the household have been found to be "carriers." In families where they have been careless in the matter of isolation the number of "carriers" has been found much higher. The public-health importance of this fact is great, for, if a person becomes a "carrier" through contact with the sick, the germs are more likely to be virulent than in "carrier" cases where no such contact can be traced.

Percentage of "carriers" among the population.—When diphtheria is only ordinarily prevalent in a community probably from 1 to 2 per cent of the population will be found to be carriers of the germ. In times of epidemics, however, and especially among the inmates of institutions where there are outbreaks, the proportion of "carriers" may be greatly increased.

Milk-borne diphtheria.—The germ of diphtheria grows freely in milk. This food undergoes so much handling during production that germs of diphtheria must often have an opportunity to get into it unless due care is taken. As a result we have many records of widespread outbreaks of diphtheria caused by such infected milk. The germs got into the milk at the farm or dairy, either because of the presence of a case of diphtheria, or because some member of the farm or dairy force was a diphtheria bacillus "carrier." The diphtheria germ has been grown in a number of instances from the milk causing such epidemics, thus proving the connection of the milk with the outbreak.

Immunity to diphtheria.—The rather frequent finding of diphtheria germs in the throats of healthy persons shows, either that they have high natural resistance to the disease or that all the conditions required to cause an attack are not present.

The conditions required are, in all likelihood (1), infection with virulent diphtheria germs, and (2) a lowered state of resistance to disease.

Persons who have had an attack of diphtheria are not likely to have the disease again. However, second and even third attacks of diphtheria are met with. As previously mentioned, age plays a part in the ease with which we catch diphtheria. Thus, babies less than a year old are seldom attacked. This, possibly, may be due to substances in the milk of the mother which protect the infant from disease. After the end of the first year children are most susceptible to diphtheria from the third to the tenth year, after which susceptibility grows less.

Temporary immunity.—Temporary immunity to diphtheria may be given by an injection, under the skin, of diphtheria antitoxin. The immunity given in this way is fleeting, and can not be relied upon to last longer than three weeks after the injection. The proceeding, however, is most useful to prevent attacks after exposure to the disease.

Treatment of diphtheria.—Preventive medicine achieved one of its greatest triumphs when it placed in our hands the specific remedy for diphtheria—diphtheria antitoxin. Were it possible to apply this remedy in sufficient dose and early enough in all cases the mortality from diphtheria would almost vanish. As it is the disease has been robbed of much of its former terror.

Principle of antitoxin treatment.—Let us now refer briefly to the principle upon which the antitoxin treatment of diphtheria is based. It is found that animals injected with slowly increasing doses of diphtheria poison or "toxin" (which, as has been stated, can be readily made in the laboratory) gradually become immune to its effects, so that they stand without harm what would be a many times fatal dose when first injected. This ability to withstand the poison is due to an antidote manufactured by the animal's body which combines with the diphtheria poison, making it harmless. Moreover, this antidote is produced in such large quantities that the blood is full of it. If, then, we take the blood of such an immune animal, allow it to clot, and draw off the clear serum in which the clot floats, this serum, when injected into another animal or human being will protect it from the effects of diphtheria poison in like manner.

Manufacture of diphtheria antitoxin.—Diphtheria antitoxin is made commercially from the blood serum of horses, because the horse has a high degree of natural immunity to diphtheria toxin, reacts to this poison when injected by producing a very large amount of antitoxin in its blood, and can be bled in large amounts without permanent injury. Only perfectly healthy horses, shown to be free from tuberculosis and glanders, and protected by tetanus antitoxin against

lockjaw, are used in its manufacture. All establishments for the manufacture of vaccines, antitoxins, and similar products used in interstate commerce are licensed, their laboratories inspected, and their products tested for purity by the United States Public Health Service, so that the general public can be assured of the purity of their output. Diphtheria antitoxins are tested for potency as well.

Potency of antitoxin.—The curative power of diphtheria antitoxin or its "potency" is measured in "antitoxin units." The antitoxin unit involves a number of theoretical considerations and is difficult to define briefly. Essentially, however, it is the power of a certain amount of a standard diphtheria antitoxin to neutralize diphtheria toxin. The United States Public Health Service furnishes this standard antitoxin with which all other diphtheria antitoxins manufactured in the United States and used in interstate commerce are compared. A strong diphtheria antitoxin should contain from 800 to 1,200 of these units to each cubic centimeter (1 cubic centimeter equals 15 drops approximately).

Results of the use of antitoxin.—From the introduction of antitoxin in the treatment of diphtheria in 1894 up to the present time the great wealth of observations which have accumulated leads us to conclude that the fatality from diphtheria has been reduced by more than one-half by the use of this remedy. That the fatality is not still further reduced is due either to the fact that not every case of diphtheria receives the antitoxin treatment, or that it is not employed soon enough, or that the dose has been insufficient.

Influence of antitoxin on the local symptoms of diphtheria.—The most marked influence of the antitoxin treatment of diphtheria upon the local symptoms of the disease consists in hindering the spread and causing the rapid absorption of the membrane. The general effect of the treatment is to shorten by several days at least the duration of the local process. Antitoxin also exerts a marked effect in reducing the odor of the breath, which is often intolerable.

The action of antitoxin in preventing the spread of the membrane is of the utmost, nay, of life-saving, importance, especially in those cases where there is a tendency for the membrane to spread to the windpipe, or when the windpipe is already affected to extend downward toward the lungs.

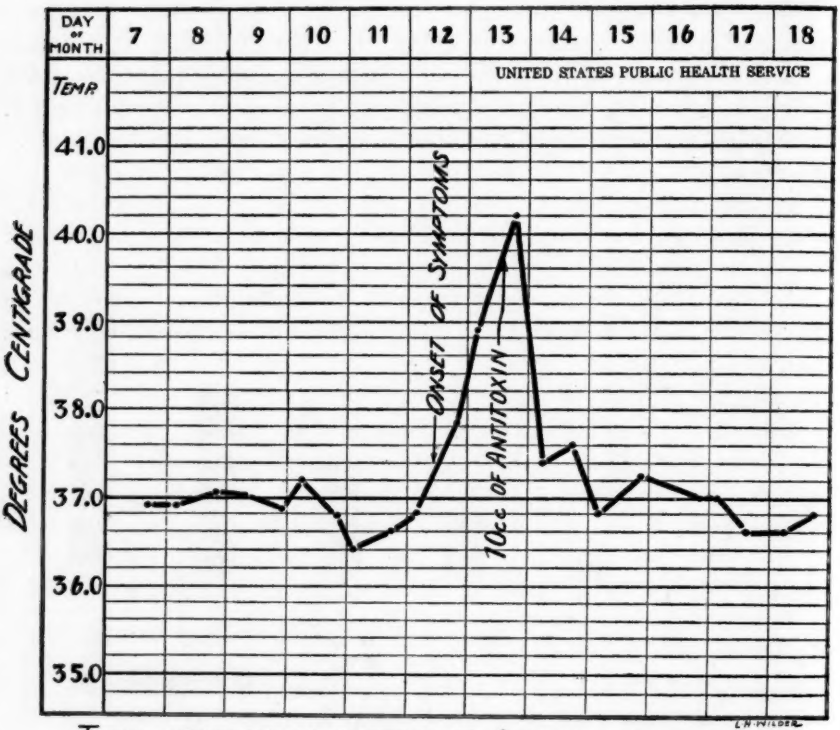
Effects of antitoxin upon the general symptoms of diphtheria.—With an improvement in the local symptoms there goes hand in hand betterment of the general symptoms. The swelling of the glands of the neck diminishes, the fever drops, the appetite commences to return, the patient feels better in every way. The following chart shows the striking effect of a dose of antitoxin on the fever in diphtheria.

Effects of antitoxin upon the diphtheria poison already absorbed.—Numerous experimental observations have shown that diphtheria

antitoxin has a curative effect upon the symptoms caused by the poison already absorbed. This, however, is true only to a limited extent. The element of time and the amount of poison which has been taken up by the body are important considerations. The bigger the dose of poison present in the system the less time there is to lose if we are to save the patient.

For antitoxin to exert its full curative effect it is necessary to anticipate as much as possible by its early administration the absorp-

CHART No. 1.—Showing the effect of an injection of antitoxin early in a case of diphtheria.



TYPICAL EFFECT OF AN INJECTION OF ANTITOXIN AT THE OUTSET OF A CASE OF DIPHTHERIA. (after KOLLE AND HETSCH)

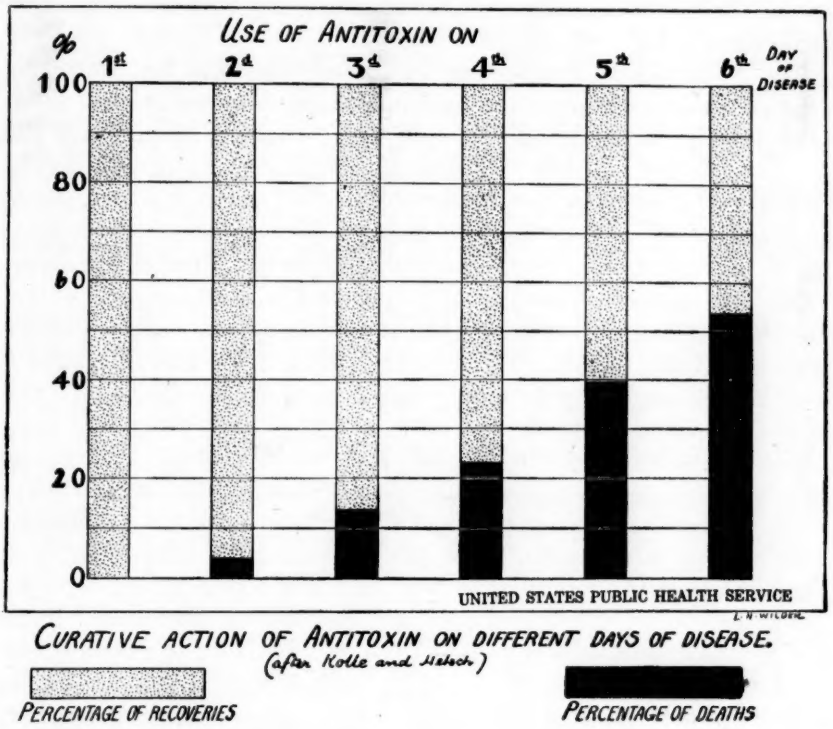
tion of the diphtheria poison by the body cells. Fortunately the appearance of the first symptoms of poisoning does not necessarily indicate that a fatal dose has been absorbed, so that, even in apparently desperate cases, the patient may yet get well if antitoxin is boldly given.

Importance of the early use of antitoxin.—We learn from the foregoing the important fact that antitoxin must be given as early as possible in the course of the disease. The following chart shows the striking difference in the fatality from diphtheria accordingly as antitoxin is administered early or late in the disease.

An examination of the chart shows, in the large series of cases upon which it is based, that when antitoxin could be given on the first day of the disease there were no deaths. When the administration was delayed to the second day about 5 per cent died. Administration on third, fourth, fifth, and sixth days showed the progressively increasing fatality of 12.5 per cent, 22 per cent, 39 per cent, and 50 per cent.

We also find a relation between the early use of antitoxin and the frequency with which the crippling paralyses, so frequent in diphtheria,

CHART No. 2.—Showing how the chances for recovery from diphtheria are increased by the early use of antitoxin.



occur. The earlier the use of antitoxin the less likelihood there is of the subsequent development of paralysis.

The overwhelming importance of the time element in the antitoxin treatment for diphtheria can not be too strongly emphasized. A few hours lost in beginning treatment may spell all the difference between life on the one hand and death or crippling on the other. When physicians as well as the general public realize that no time is so precious as that lost at the outset, in the treatment of diphtheria, and that the energetic, early use of antitoxin creates mastery of the situation, not only will many valuable lives be saved, now wasted by timidity and procrastination, but material assistance will be secured in limiting the spread of epidemics.

Methods of use and dose of antitoxin.—While the administration of the antitoxin treatment of diphtheria is necessarily in the hands of the attending physician, a few remarks as to its use and the proper dose will not be out of place.

Antitoxin is placed upon the market by the manufacturers, in sterile containers, usually in syringes, ready for use, with the potency, in antitoxin units per cubic centimeter, plainly stated on the label.

The usual mode of administration is to inject the remedy directly under the skin of the flanks or between the shoulder blades, the site of the injection having been previously cleansed with care, in order to avoid infection with the pus germs so constantly present on the surface of the skin.

The average dose recommeded is 600–1,000 units for protecting persons who have been exposed to diphtheria infection. Three thousand units is the average dose employed for curative purposes. While the protective dose employed is probably adequate, stress should be laid upon the fact that this curative dose is too small. The experience of numerous observers has shown that the proper dose of antitoxin is the one necessary to secure the characteristic curative effect. This consists, as is well known, in an improvement of the general condition, fall of the fever, shrivelling of the membrane, and lessening of the evil odor of the breath. The administration of the antitoxin, therefore, should be boldly pushed, regardless of the amount employed until this effect is secured.

We must also be guided, in selecting the first dose, by the time which has elapsed since the onset of the disease. When several days have passed or symptoms of poisoning are present there is no use wasting time with small doses. If, from the facts in the case, it is apparent that the patient has been sick more than three days, we must regard his life as having already been endangered. While severe poisoning may occasionally result with only trifling local symptoms the state of the affected parts is a pretty good index of the amount of poisoning likely to ensue. A rapidly spreading membrane, fetid breath, great swelling of the lymphatic glands of the neck, a blood-stained discharge from the mouth and nose are signs that the case is severe and dangerous, and symptoms of poisoning are to be expected unless averted by a big dose of antitoxin. Any symptoms of the extension of the membrane to the windpipe, as shown by huskiness or a whispering voice, is a signal for fresh administration of the remedy. It is important to remember that the liberal use of antitoxin is our only means for preventing the extension of the disease in the body.

The presence of kidney involvment, somnolence, listlessness, a fretful, peevish voice, a small and rapid pulse, are to be regarded as symptoms of poisoning. A fresh rise in the temperature with noth-

ing to account for it is to be regarded as due to an additional quantity of diphtheria poison which has been absorbed. Urgent symptoms of advanced poisoning are a sudden rise in the pulse rate, a fall to an abnormally low rate, ashy color of the face, clammy skin, vomiting, tossing of the body. These call for correspondingly large doses.

To be on the safe side, the first dose of antitoxin should never be less than 10,000 units. As much as 100,000 units have been administered in desperate cases with resulting recovery.

In severe cases we can increase the effect of the antitoxin without increasing the dose by injecting it directly into a vein, instead of under the skin. It takes a certain time for antitoxin to be absorbed from the site of the skin injection, so several valuable hours are saved if the antitoxin enters directly into the circulation. The injection of the remedy into the muscles instead of under the skin is also a time saver. Antitoxin is much more rapidly absorbed under such circumstances. The result of investigation shows that antitoxin, when administered in the muscles, is probably several times as efficient as when given under the skin, because of the more rapid rate of absorption.

Undoubtedly the question of cost must be considered in connection with the antitoxin treatment of diphtheria. Large doses of the remedy cost more than small. The difference in the results, however, with large doses as compared to small is so great that it overshadows any question of expense. It is to be earnestly hoped that the day is not far distant when antitoxin will be furnished by States and municipalities free, on demand, in sufficient quantities to insure to all persons sick with diphtheria adequate curative doses.

Harmful effects of antitoxin.—We sometimes see a number of disagreeable symptoms following the use of antitoxin which precede and accompany a sickness, known as "serum sickness," which lasts some 8 or 10 days. There is slight reddening of the site of injection and swelling of the neighboring lymphatic glands. The next symptom is an eruption, most intense at the spot where the antitoxin was injected and the surrounding skin, which belongs to the group of nettle rashes. The eruption soon spreads over the whole body and may be be very itchy. Often the eruption is measly or may bear a resemblance to the scarlet-fever eruption. On the other hand, the eruption may be scanty and transient. Some fever is usually present. In addition to the above there are often localized swellings of the shin, knuckles, or conjunctiva. More infrequently there are pains in the joints which may give great discomfort and difficulty in handling the patient.

The symptoms of serum sickness are not due to the antitoxin itself, but because the serum injected is from another class of living beings, viz, the horse.

Hypersensitiveness.—Occasionally individuals are found in whom the injection of antitoxin is followed by severe collapse and even death. This is not due to the antitoxin but because horse serum is poisonous to such individuals. Fortunately such persons are rare. The tendency to be poisoned by horse serum seems peculiarly marked in persons who suffer from bronchial affections and asthma. Some individuals are so sensitive that they can not work in the vicinity of horses without being subject to asthmatic attacks.

When, therefore, the question of administering antitoxin for diphtheria to such an individual comes up we should proceed with caution. It has been suggested that individuals supposed to be sensitive be tested by giving them a minute trial dose of the antitoxin at first, so that, if sensitive, the symptoms will be slight. If nothing happens, the rest of the dose is administered.

The diagnosis of diphtheria.—We readily understand from the foregoing that the correct diagnosis of diphtheria plays a very important part in the problem of its control. Not only does the safety of the community depend upon the detection and isolation of cases of diphtheria, but the early recognition of the disease diminishes the mortality because treatment also is earlier. A positive diagnosis is made by detecting the germ in the noses or throats of the sick by the methods previously described.

Twenty-four hours or so of valuable time must elapse before the bacteriological diagnosis can be made. When diphtheria is prevalent we should not wait for the bacteriological examination in cases of sore throat, particularly when more than one member of a family is affected. Under such circumstances the individual should be isolated and antitoxin administered while awaiting the result of the examination of the throat cultures. If the result of the examination is negative, no harm has been done, while if the illness is diphtheria, we have gained just so much time and possibly saved a life. Much could be accomplished in limiting the spread of communicable diseases if it were the rule in every household to isolate all children as soon as they become sick, until the nature of their illness has been made out, especially where such illness is accompanied by sore throat, running nose, or huskiness of voice.

Care of diphtheria in the home.—Proper care of the diphtheria patient in the home is the keystone in the control and prevention of diphtheria. It is here that the private citizen, if he does his full duty, becomes an efficient unit in the campaign against preventable disease. The communicability of diphtheria and the fact that "carriers" of the germ result from contact with persons sick of the disease, renders imperative the strict isolation of diphtheria patients.

The sick room.—The first rule in the care of diphtheria in the home is to place the patient in a separate room. This room should, if

practicable, be on the story of the house the least in use, though its adaptability as a sick room should be taken into account. Rugs, carpets, draperies, and all upholstered furniture are to be removed. What furniture is left should be of a kind which may be readily cleansed.

There is no need for fancied attempts at purifying the air by means of hanging sheets wet with disinfectants and the like. If possible, the mattress should be completely covered with a rubber sheet which can be washed from time to time with a disinfectant solution.

Separate linen, bed clothing, etc.—Separate towels, bed clothing, nightgowns, eating utensils, and drinking vessels should be provided for the patient's exclusive use. These should always be kept free from contact with those used by the rest of the family. After being used by the patient they are to be soaked for an hour or two in one of the disinfectant solutions given below and then boiled for one-half hour in soapsuds.

Attendant for the patient.—The patient should be provided with an attendant who remains with the patient and holds no communication with the other members of the family. This attendant should be the only person caring for the patient or coming in contact with him, apart from the attending physician.

Use of disinfectants.—A tub of good disinfectant solution should be at hand for soaking articles which have been used by the patient. A basin of disinfectant should also be provided for cleansing the hands of the attendant.

Proper disinfectant solutions are—

(*a*) Two per cent solution of phenol (carbolic acid);

(*b*) Two per cent solution of liquor cresolis compositus, U. S. P. (compound solution of cresol).

A 2 per cent solution is made by adding 3 ounces (6 tablespoonfuls), of the disinfectant to 1 gallon of water.

All surfaces soiled by discharges from diphtheria patients should at once be flooded with the disinfectant solution.

All articles used by the patient should be soaked for one to two hours in the disinfectant solution, and then boiled for one-half hour in soapsuds. Discharges from the nose and throat of the patient are to be received into pieces of cotton gauze, or old, clean squares of linen, which are then placed immediately after use into the solution of disinfectant. They are then burned. Partially eaten food is also disposed of by being burned.

Care of the attendant's hands.—It is important to remember that the hands are extremely likely to become infected with diphtheria germs when caring for diphtheria patients. Unnecessary handling of the

patient should, therefore, be avoided. Whenever this is necessary the hands should be cleansed first in disinfectant solution and then in hot soapsuds. This precaution must always be taken by the attendant before eating.

Other precautions for the attendant.—A loose gown or a wrapper should be provided to protect the attendant's clothing. This covering should always be regarded as infected and not sent out of the room until it has been soaked in disinfectant for an hour. It should then be boiled. In the case of female attendants, the hair should be completely covered by a cloth or hood when engaged in caring for the patient. The patient may cough violently in the attendant's face, thus spraying the attendant with the mouth and throat discharges, and, possibly bits of membrane. If this happens the face should at once be washed in disinfectant solution, including the hair if it has been uncovered. If the hair has been covered, the covering should be placed in the disinfectant solution.

Gowns and head coverings should also be provided for the attending physician. These are kept outside of the room and are soaked in disinfectant for an hour, and then boiled in soapsuds for one-half hour immediately after use.

It is advisable that the attendant use a mouth wash regularly. A good one for this purpose is made by mixing 1 ounce of peroxide of hydrogen in a glass of water and adding 10 or 15 drops of a 10 per cent alcoholic solution of thymol.

Immunizing the attendant.—All attendants on diphtheria cases should receive a protective dose of diphtheria antitoxin. At the first sign of any throat trouble a full dose should be given.

Cleansing the room.—The room should be thoroughly aired two or three times a day. In cold weather the patient should be protected from draft by covering the head with a sheet. No sweeping should be done, but the floor and furniture wiped up with cloths dampened in disinfectant solution. After use the cloths should be soaked in disinfectant.

Bath after recovery.—After recovery the patient's entire body, including the hair, should be bathed in warm soapsuds. The patient should then be removed from the room and dressed in clean clothes which have not been in the room during the sickness.

Subsequent treatment of the room.—The subsequent cleansing and disinfection of the room, after the patient's recovery will, in cities, be covered by the regulations of the local board of health. When the householder must follow his own initiative in this matter the following measures should be carried out:

The room should be thrown open freely to the air and sunshine. All bed linen, towels, nightgowns, and the like are to be disinfected

in the manner previously described. Books and toys used by the patient should be burned. The floors and the walls, up to a height easily within reach, should be thoroughly scrubbed with a hot disinfectant solution. Mattresses are best disinfected by steam. Otherwise, they should be burned. If, however, they have been thoroughly protected by a rubber sheet, after removal of the latter they may be sunned on both sides for a number of successive days.

Reporting the case.—The efficient control of diphtheria depends upon exact knowledge of its prevalence. It is the public duty, therefore, of all citizens to report cases of diphtheria to the sanitary authorities and to have the houses in which such cases exist placarded.

It is, similarly, the duty of the householder scrupulously to observe all regulations made by the local health department with respect to the quarantine of diphtheria cases. All cases of sore throat, especially if occurring in more than one member of a family, should be regarded as suspicious. The affected persons should be isolated and steps taken to have throat cultures sent to the health office for examination.

Duration of isolation in diphtheria.—Persons suffering from diphtheria should be isolated until cultures taken from the throat on at least two successive occasions fail to show the presence of diphtheria germs.

While diphtheria germs may persist in the throats of convalescents for periods of time which will try the patience of the most philosophical, nevertheless, the rôle played by "carriers" in the spread of the disease is so important that the necessity for enforcing this rule is obvious.

Other precautions.—When a household in which there is a case of diphtheria is engaged in any occupation having to do with the handling or distribution of food, such as the grocery business, dairying, and the like, such occupation should be discontinued until recovery of the patient from diphtheria, and diphtheria germs are found to be absent from the throats of all the members of the family.

Should the patient be removed to a hospital for contagious disease, business should not be resumed by the other members of the family until it has been shown that diphtheria germs are absent in cultures from the throats of all the other members of the family, and the necessary cleansing and disinfection of the premises have been done.

Public prevention.—It is plain that all the precautions enumerated can not be carried out in the tenement districts of cities. The presence of overcrowding, so common in tenement districts, alone is sufficient to prevent the thorough isolation of persons suffering from diphtheria.

Under such circumstances the control of the disease must be in the hands of the local sanitary authorities.

Organization for the public control of diphtheria.—The following are necessary for the efficient public control of diphtheria:

1. A properly organized health department with a competent health officer at the head.
2. The prompt notification of all cases of diphtheria.
3. A laboratory for the bacteriological diagnosis of diphtheria.
4. A sufficient corps of inspectors and nurses for the visiting and control of diphtheria cases reported.
5. A contagious-disease hospital, to which persons suffering from diphtheria can be moved when, from an inspection of their premises, it is evident that they can not remain at home without danger to others.
6. The free distribution of antitoxin on demand.
7. Maintenance of the quarantine of persons suffering from diphtheria until at least two successive throat cultures fail to show the presence of diphtheria germs.
8. A sufficient number of stations at convenient points at which outfits for making throat cultures can be obtained.
9. An adequate system of physical supervision of school children.
10. Public-spirited cooperation on the part of the health department, the medical profession, and the public.
11. Abolition by ordinance of the common drinking cup and common towel.

Treatment of "carriers."—The treatment of diphtheria-bacillus "carriers" is still a difficult problem.

So far as actual cases of diphtheria are concerned, these should be kept isolated until two successive throat cultures are negative. There can also be no doubt as to the propriety of excluding children who are "carriers" from schools, or of prohibiting "carriers" who have to do with the handling of foodstuffs from engaging in their occupation until their throats are free from diphtheria germs.

When diphtheria is prevalent in any community, it is likely that a considerable percentage of healthy persons will be carriers. It is clearly impracticable to quarantine all healthy persons who have diphtheria bacilli in their throats. If, however, it were possible to diagnose early every case of diphtheria, and to secure its strict isolation until throat cultures are negative, it is probable that the number of "carriers" in a community would, thereby, be greatly reduced.

It seems likely that the best thing to do with "carriers" when they are not school children, or engaged in the handling of foodstuffs, is to give them a dose of antitoxin and let them go, directing attention to the use of mouth washes and giving instructions with respect to the precautions to be taken in associating with others, especially with children. It is not the actual presence of the diphtheria germs in the throat, but their virulence and, in all probability, their num-

bers that render the "carrier" dangerous. As in most communicable diseases a certain dose of the germ seems to be required before we contract diphtheria. The actual diphtheria case scatters the germs in relatively large amounts. By giving the "carrier" a preventive dose of antitoxin we prevent the subsequent development of diphtheria, in his case, and thus diminish his danger to the community.

In outbreaks of diphtheria in institutions, however, "carriers" should be isolated until their throats are free from diphtheria germs.

The isolation of "carriers" in institutions affected with outbreaks of diphtheria has been followed with brilliant results in cutting the outbreak short.

General precautions against diphtheria.—The natural resistance of the human is a very real safeguard against contracting communicable diseases. Hence, everything which tends to increase this resistance is of service in warding off attacks of diphtheria. Attention to personal hygiene, and the maintenance of a robust state of health by the use of suitable food, exercise, and plenty of fresh air should be of service in reducing susceptibility.

Among the special physical conditions which, in children, probably play a part in diminishing resistance to diphtheria infection are various diseased conditions of the nose and throat, such as adenoids and enlarged tonsils. When these are present in children the condition should be corrected, as the presence of these defects, besides increasing the liability, not only to diphtheria but also to other diseases, exerts an unfortunate influence on the physical development.

In addition to attention to personal hygiene the importance of the mouth as a gateway of infection should be explained to the guardians of children and an endeavor made to teach the children that the only things which naturally belong in the mouth are food and drink.

It is of course realized that especially with young children the habit of carrying everything to the mouth is instinctive. We should make an effort, however, as early as possible to counteract this habit and teach particularly the danger of such practices as putting pencils, coins, and similar objects in the mouth, the use of the common towel and drinking cup, taking bites of the same apple or piece of candy and, in a word, all acts which lead to an exchange of the mouth fluids between human beings.

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